NASA

Lewis Research Center

Cleveland, Ohio

(NASA-TM-102956) NASA LEWIS RESEARCH CENTER: A WORLD LEADER IN ADVANCED TECHNOLOGY (NASA) 30 p

N91-70617

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Lewis Research Center

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A WORLD LEADER IN ADVANCED TECHNOLOGY

The Lewis Research Center develops advanced technology for high-priority national needs. The men and women who work here add to the sum of human knowledge and contribute to our country's economic health while growing and advancing personally and professionally.

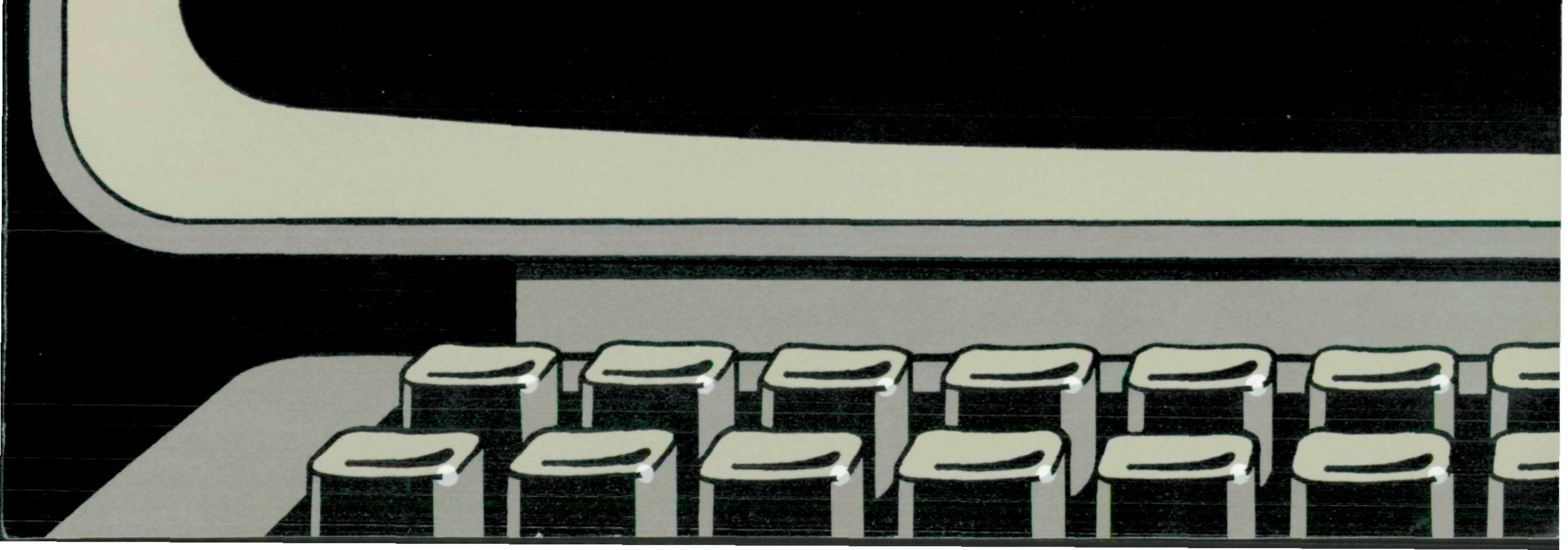
The work being done at Lewis is exciting. Soon, Earth will no longer be the only permanently habitable site for human life and work. We will explore deep space and establish orbital, lunar, and planetary colonies. Within and from those colonies, we will expand our understanding of the universe. In gravity fields as little as one one-hundred-thousandth of Earth's gravity, we will develop novel materials and processes.

As a leader in laying the technological foundation on which humankind will base these great strides, Lewis is playing a key role in major programs that will continue into the next century—propulsion systems for high-speed flight, the electric power system for the space station, space communications, electric power for deep space exploration, and a host of research projects in the basic physical and materials sciences.

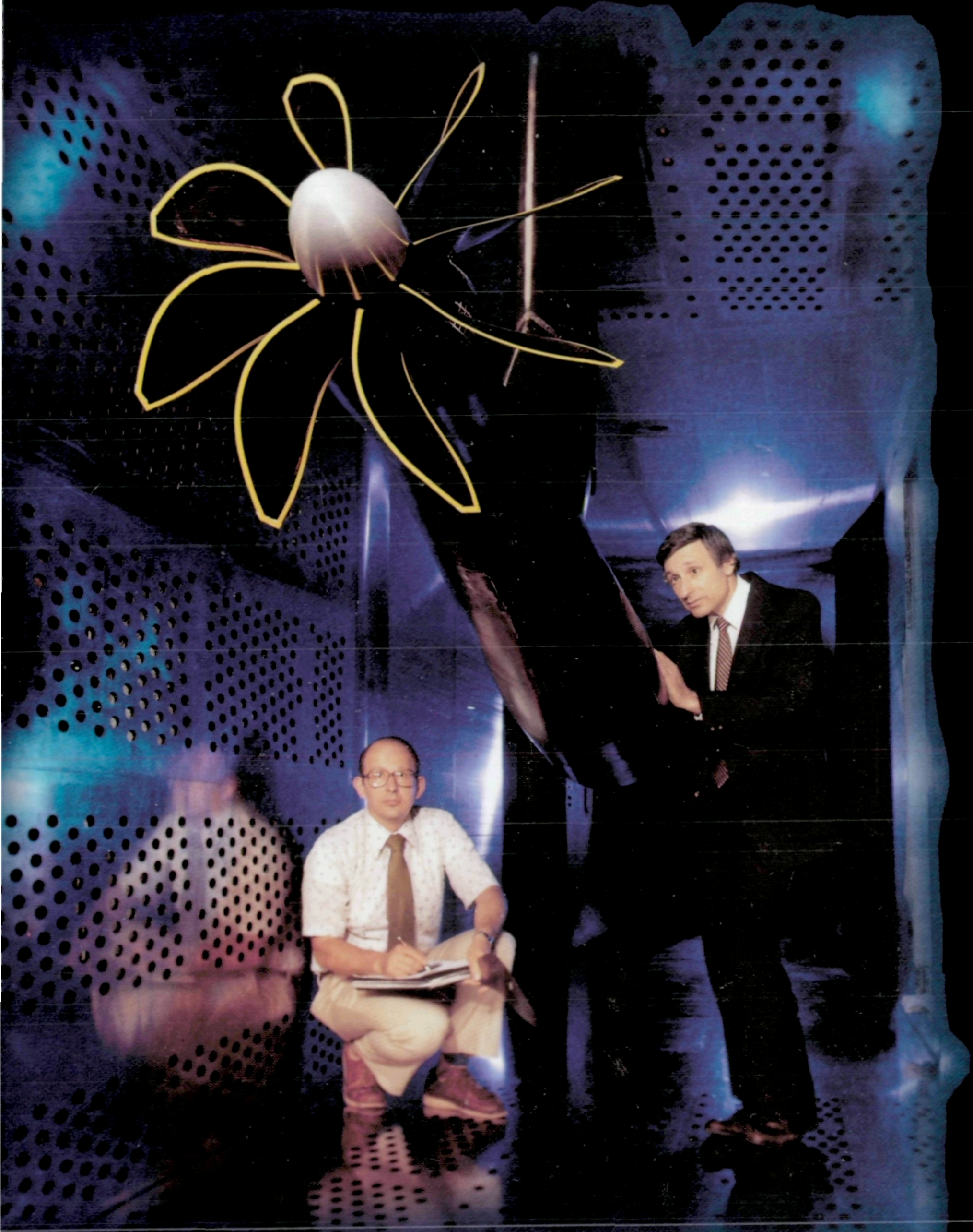
Lewis is a national resource and is recognized as an important asset by the local community and the state. One unique feature at the Center is the new Microgravity Materials Science Laboratory. The MMSL was conceived and built to help U.S. companies gain an advantage in international competition by developing better materials through microgravity research. Supersonic wind tunnels, icing research facilities, and space vacuum chambers are among the other major support facilities at the disposal of Lewis researchers.

Lewis has established an Office of Space Commercialization to encourage and assist U.S. companies to invest in space for profit. This new capability builds on a long and productive tradition of working with the private sector to develop and apply advanced technology.

Future contributions from Lewis will depend, as they have in the past, on the skillful work of a staff that is committed to excellence. This brochure will acquaint you with the challenging programs for which Lewis is responsible.

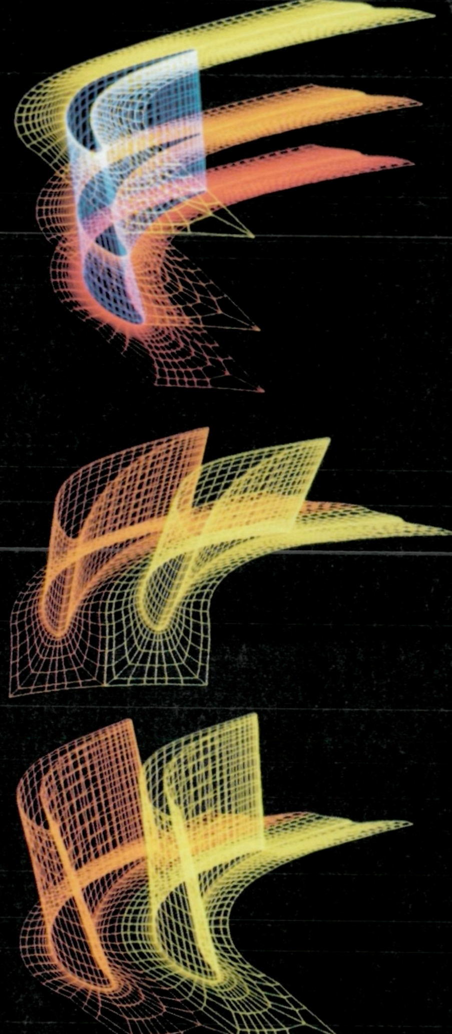


AIRCRAFT PROPULSION



Propulsion work at Lewis contributes to the preeminence of U.S. civil and military aircraft. Many years ago, Lewis demonstrated that aircraft engines can be quieter, cleaner, and more fuel efficient and at the same time give longer service life. Today, as a world leader in aerospace propulsion systems, Lewis is taking an aggressive posture in developing subsonic, supersonic, and hypersonic technology.

The performance potential of propulsion systems for use on high-speed transports for transoceanic and transatmospheric flight is being assessed, and research is being conducted on unique components for those systems. Of particular interest is the joint NASA/Department of Defense program for an aerospace plane that can take off horizontally and accelerate to Earth orbit. Lewis also is developing technology for a supersonic short-takeoff/vertical-landing fighter aircraft in a program being pursued jointly with the United Kingdom.

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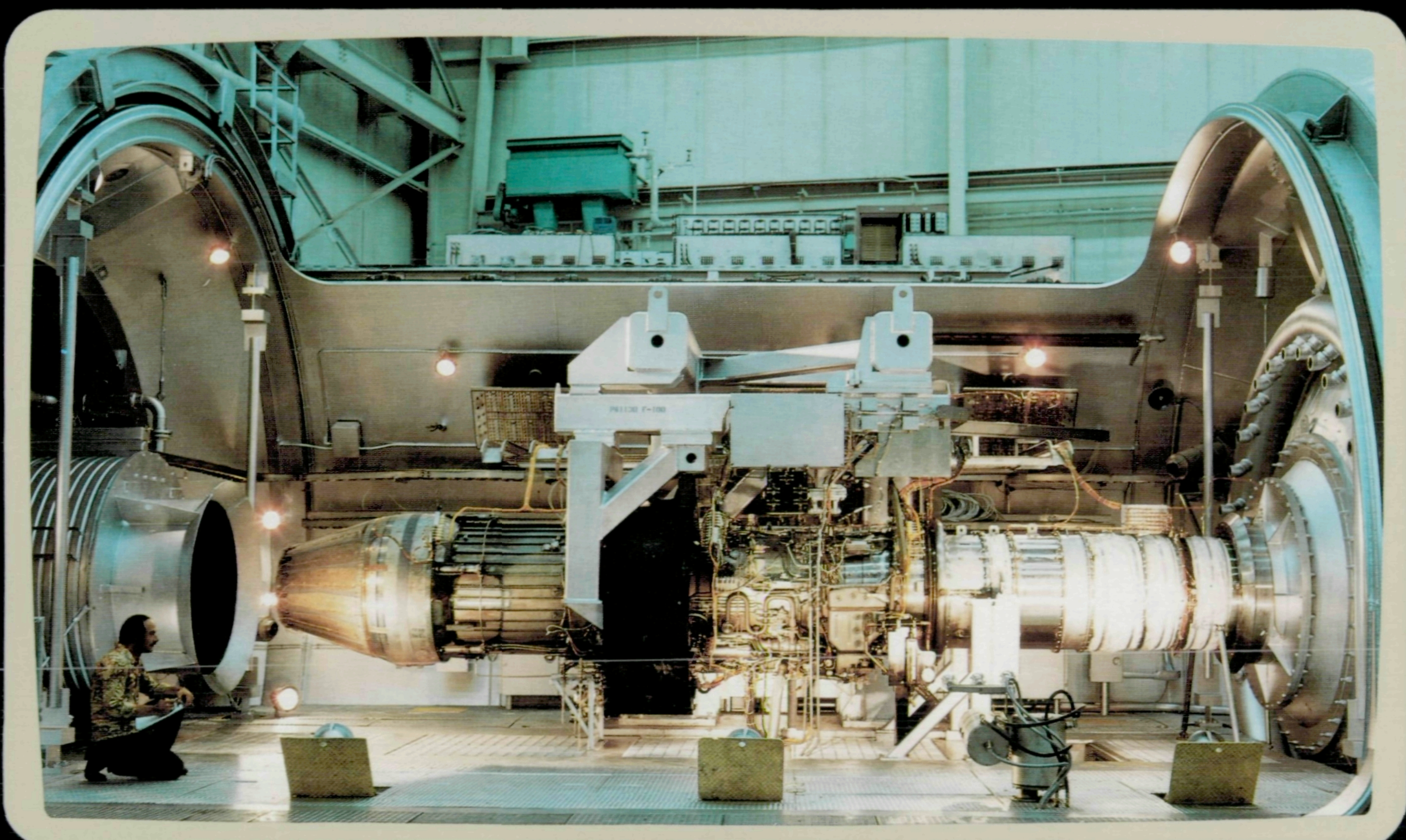
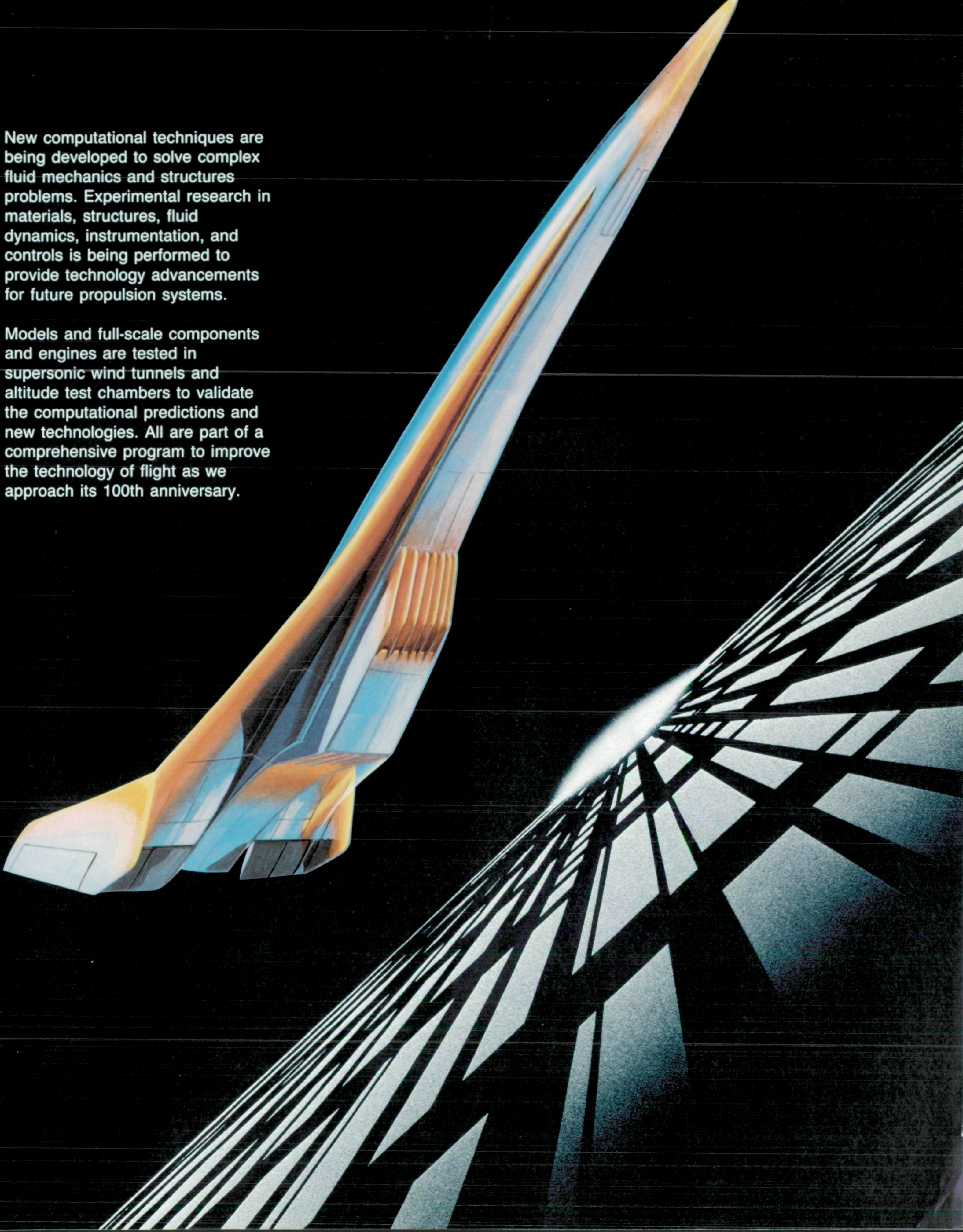
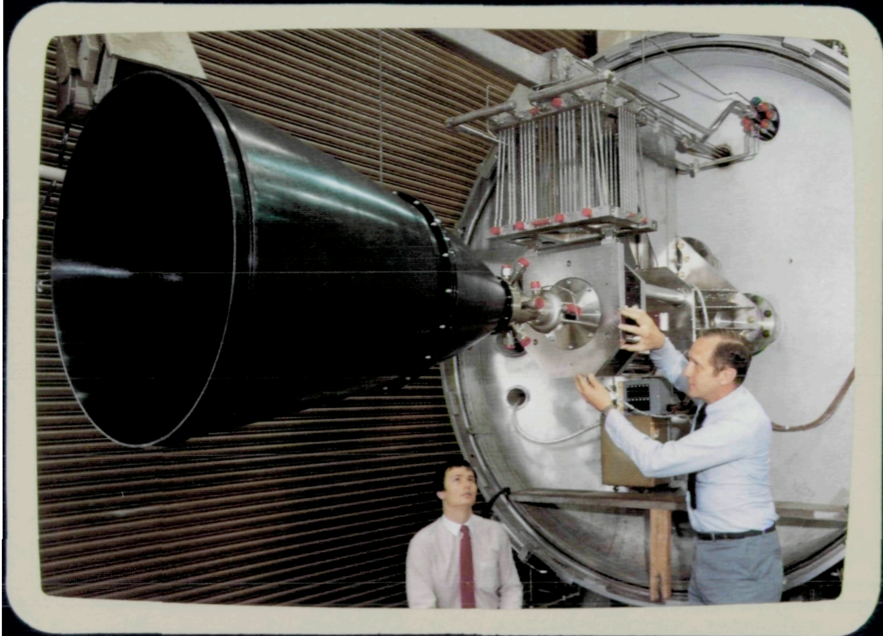


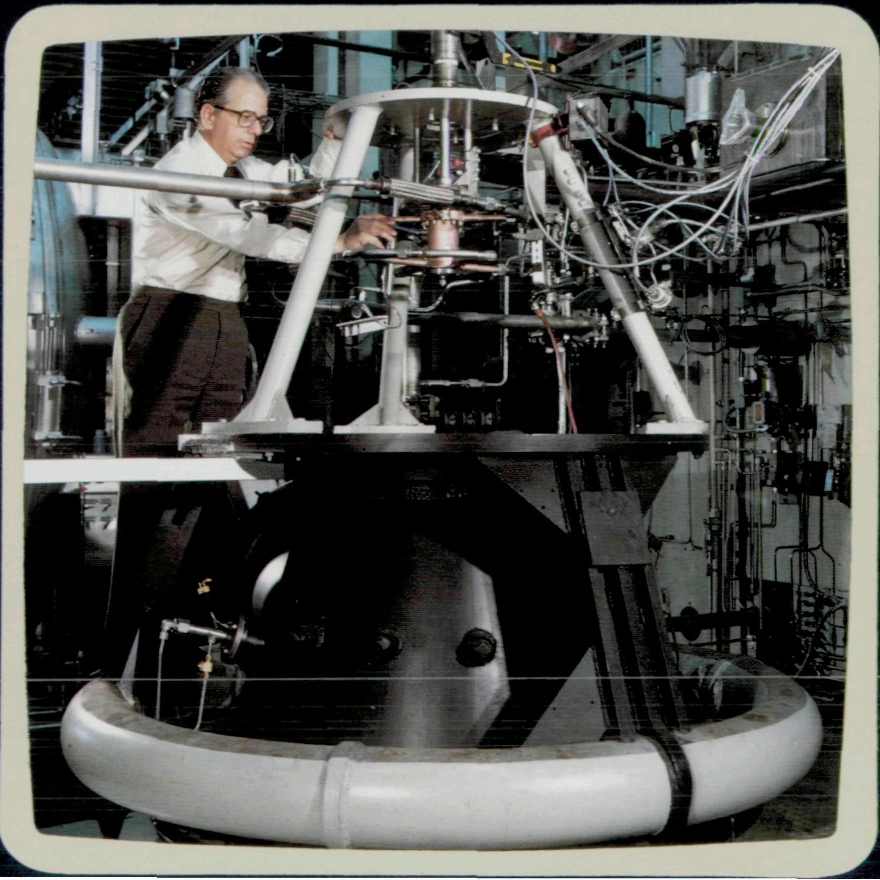
New computational techniques are being developed to solve complex fluid mechanics and structures problems. Experimental research in materials, structures, fluid dynamics, instrumentation, and controls is being performed to provide technology advancements for future propulsion systems.

Models and full-scale components and engines are tested in supersonic wind tunnels and altitude test chambers to validate the computational predictions and new technologies. All are part of a comprehensive program to improve the technology of flight as we approach its 100th anniversary.



SPACE PROPULSION





Earth-to-Orbit Propulsion

With the advent of the space shuttle, liquid-fueled rocket engines for Earth-to-orbit space propulsion systems entered a new era. The reusable shuttle engines burn liquid hydrogen, but for heavier payloads an advanced engine operating on denser hydrocarbon fuels will be needed. Such an engine must operate at far higher pressures and temperatures and get more power from its propellants than any of its predecessors. Lewis is working to make reusable engines more durable while maintaining or enhancing their performance.

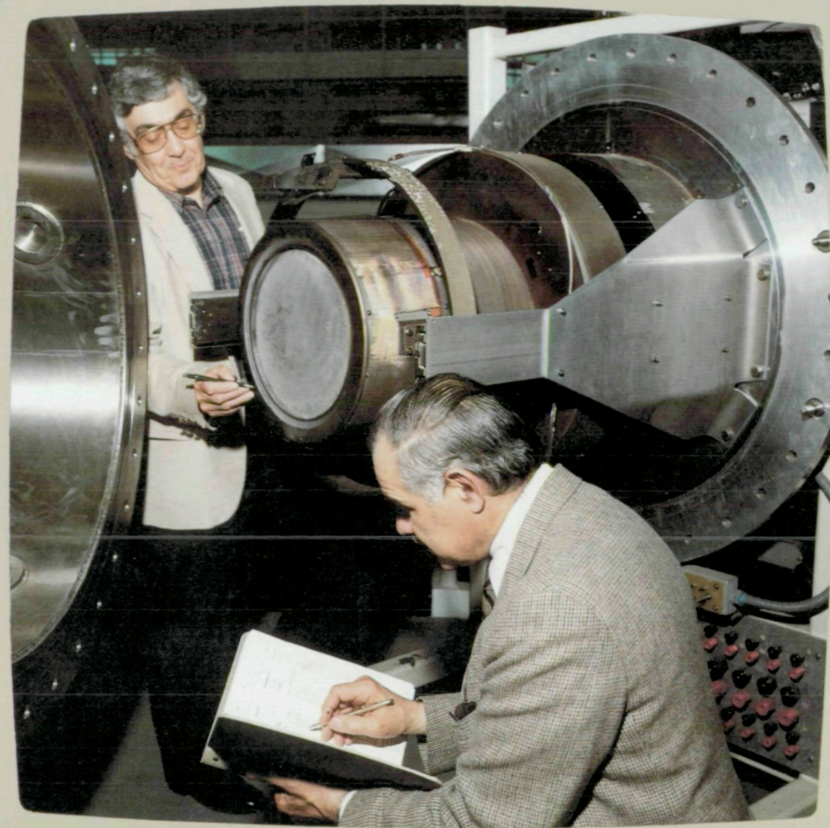
Lewis is a prominent contributor to the development of expendable launch vehicle (ELV) technology and has managed over 100 launches. The Center will continue to play a major role in ELV programs using Centaur-, Atlas-, and Titan-based systems.

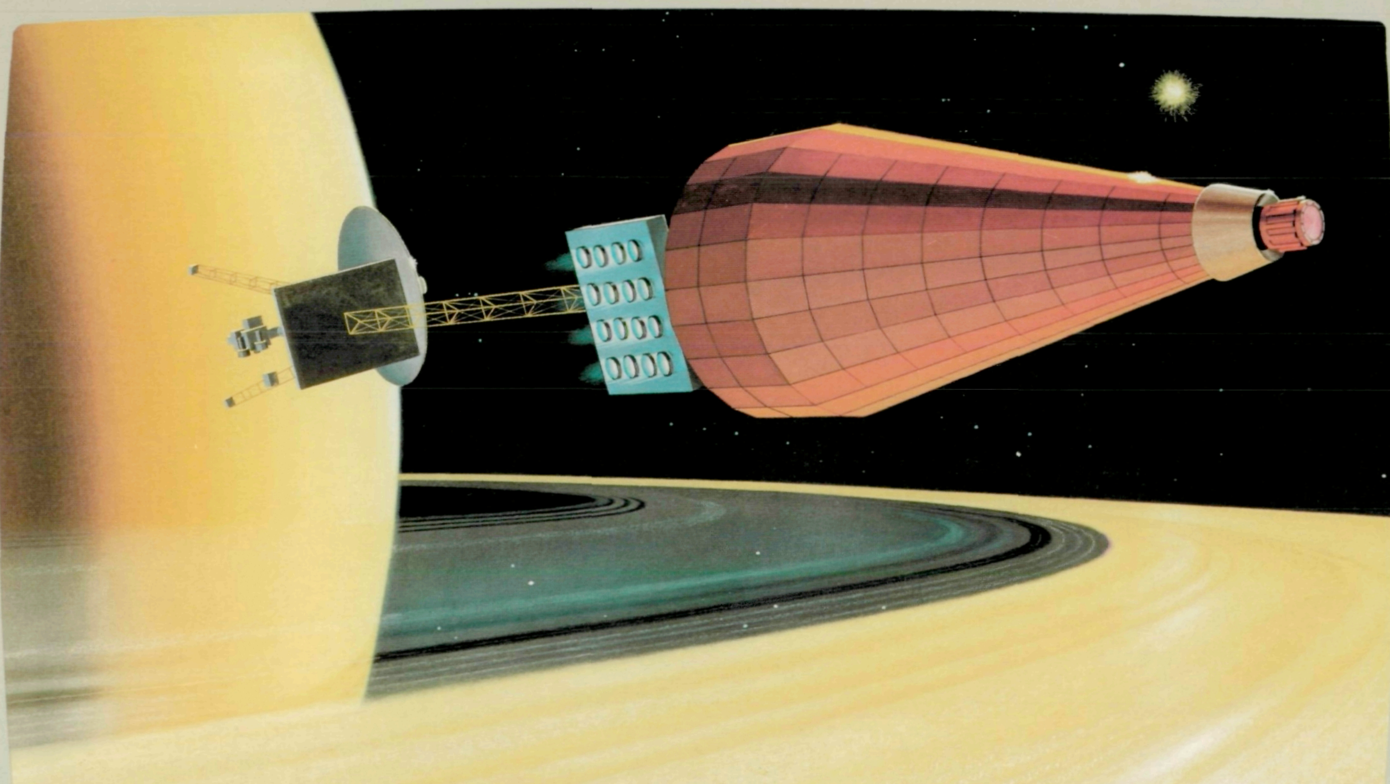
Orbit-to-Orbit Propulsion

In the 1990's and beyond, a space-based, fully reusable vehicle will be needed to transfer payloads between low Earth orbit (150 miles) and geosynchronous (22,300 miles) or other high Earth orbits. Both the orbit transfer vehicle and its rocket engines must incorporate advanced designs. Lewis is responsible for providing the technology on which the development of these advanced rocket engines will be based. Key challenges in performance, durability, and on-orbit servicing must be met. We already have defined several advanced engine concepts and are evaluating them analytically and experimentally through in-house and contracted programs.

Electric Propulsion

Electric propulsion can be of great benefit to space exploration efforts into the next century. Lewis is using its unique large space simulation chambers and powerful computational capabilities to address a range of specific electric propulsion concepts for Earth orbital and planetary space missions. Ion thruster systems are candidates for difficult planetary missions such as the Saturn Ring Explorer. Resistojets are being developed for the space station, and arc jets for geosynchronous communications satellites.

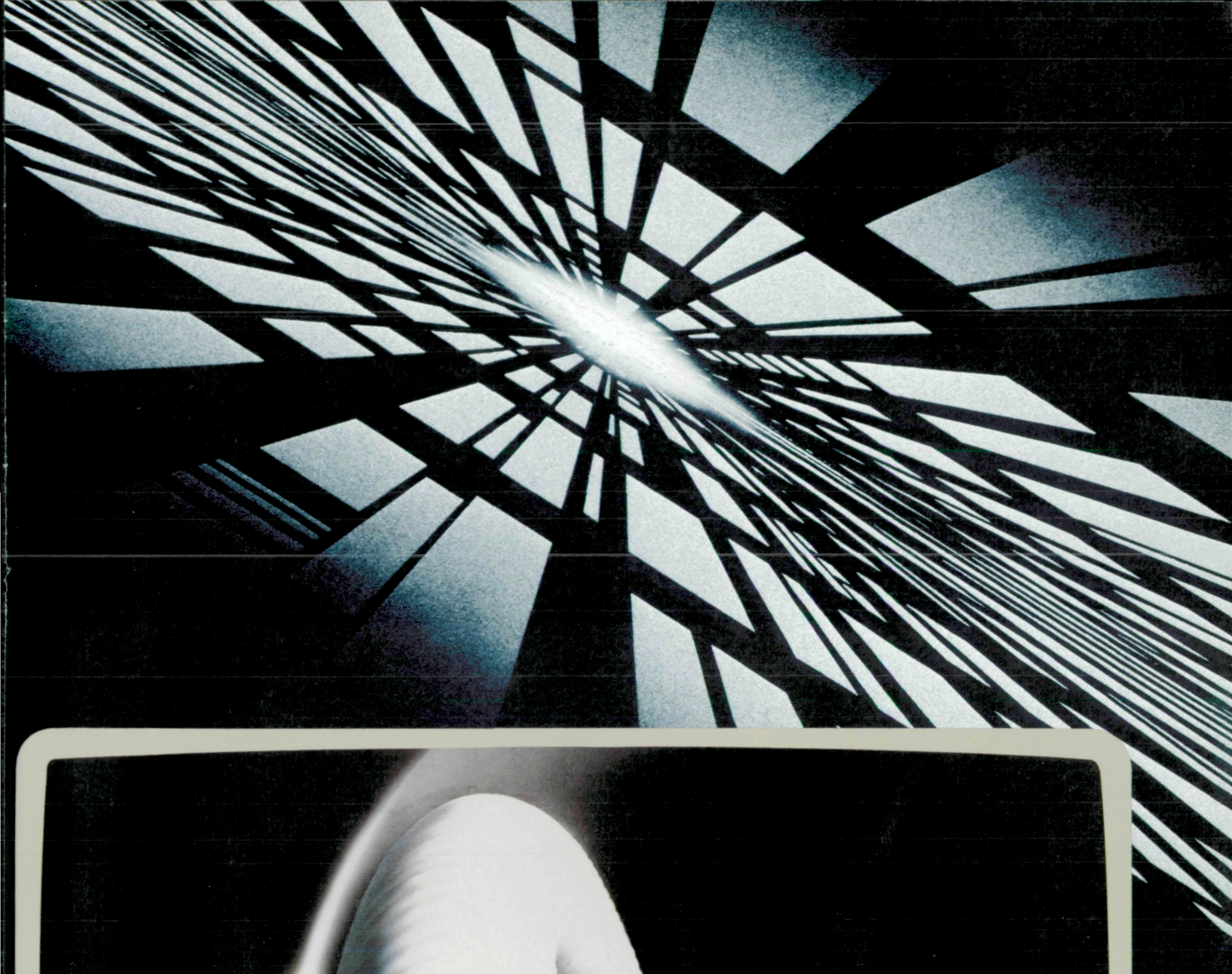


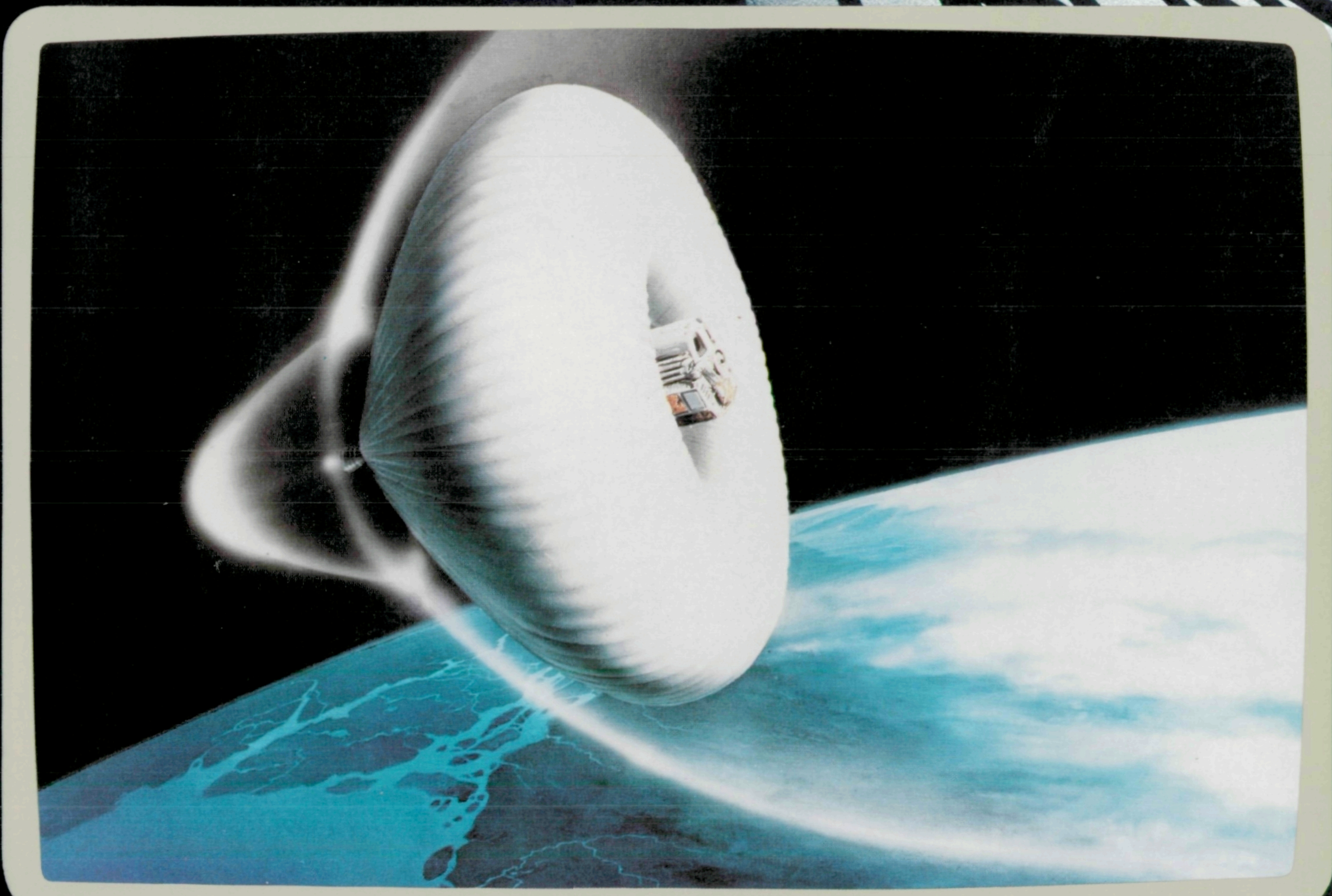


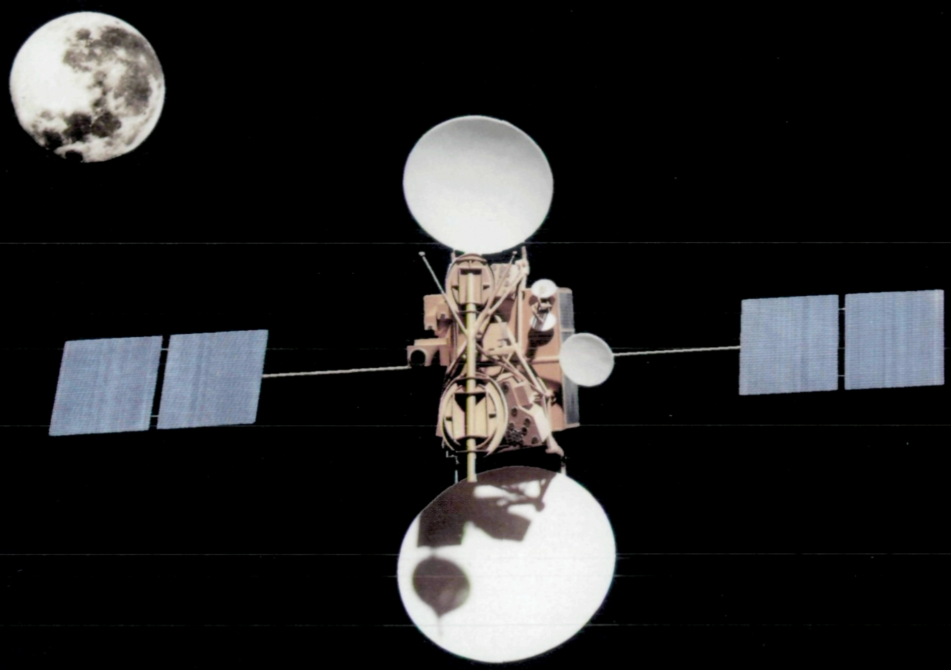
SPACE EXPERIMENTS

Lewis has been involved since the late 1950's in space experiments, first aboard expendable launch vehicles and then aboard the space shuttle. The Lewis Space Experiments Division provides a Centerwide focus for planning, advocating, managing, and implementing space experiments in science and technology. We also are planning the use of space station laboratories for science, technology, and processing studies. Experiments being readied for the shuttle encompass both basic and applied science, materials science, combustion science, and fluid physics, as well as technology development, ion auxiliary propulsion, cryogenic fluid management, voltage operating limits, and thermal management.

Lewis is committed to expanding its role in space experiments to support NASA's applications, technology, and space station programs.



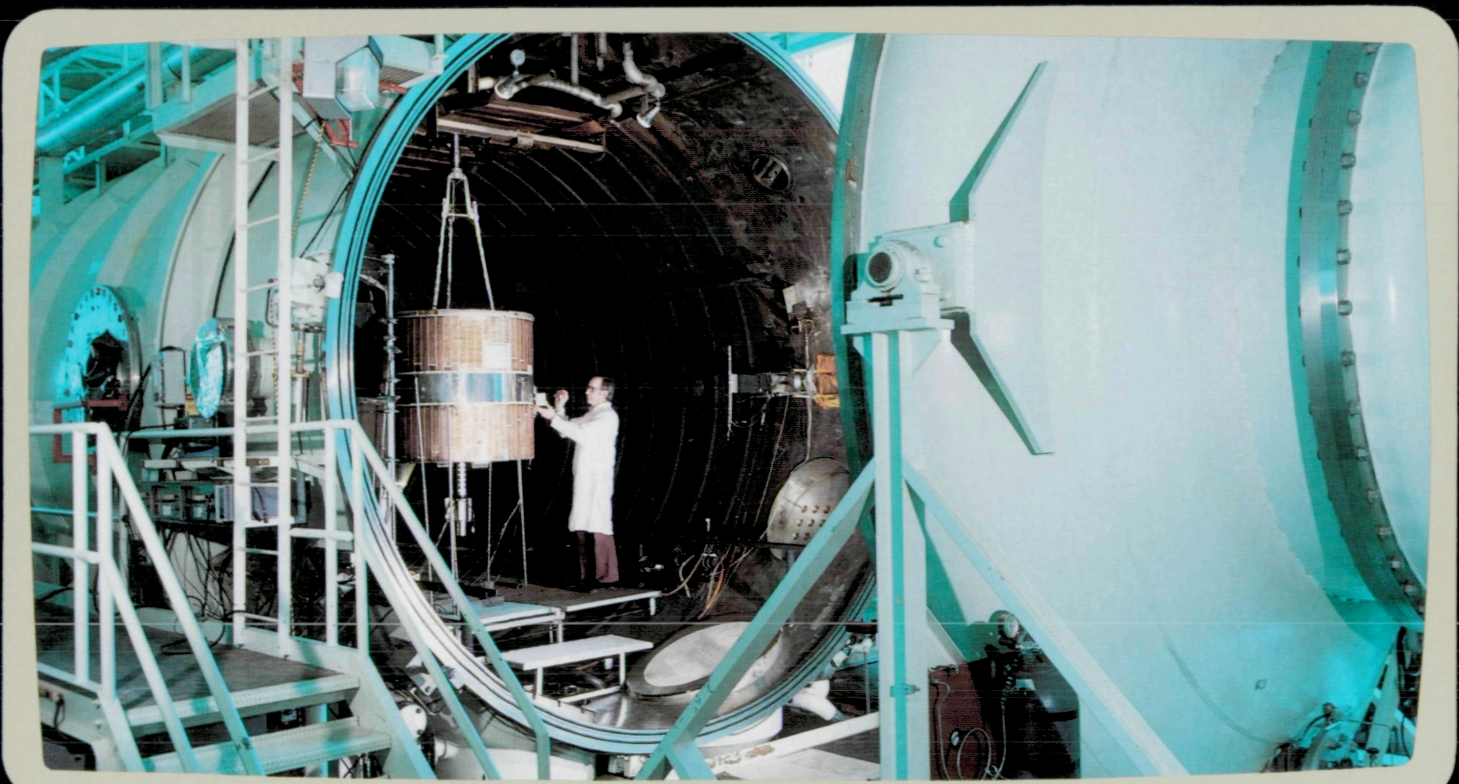




Communications

NASA gave birth to satellite communications in the 1960's, and today the world is reaping the benefits of improved communications services at lower costs. The recent information explosion has dramatically expanded the need for communications capacity and requires major advances in technology. Lewis is focusing on technologies to enable more efficient use of the geosynchronous orbit arc and higher frequency bands (from hundreds of megahertz to above 100 gigahertz).

The Advanced Communications Technology Satellite (ACTS) is an experimental flight system. ACTS pioneers new technologies in spacecraft switching, baseband processing, and multibeam antennas.



Advanced Power

Static Systems

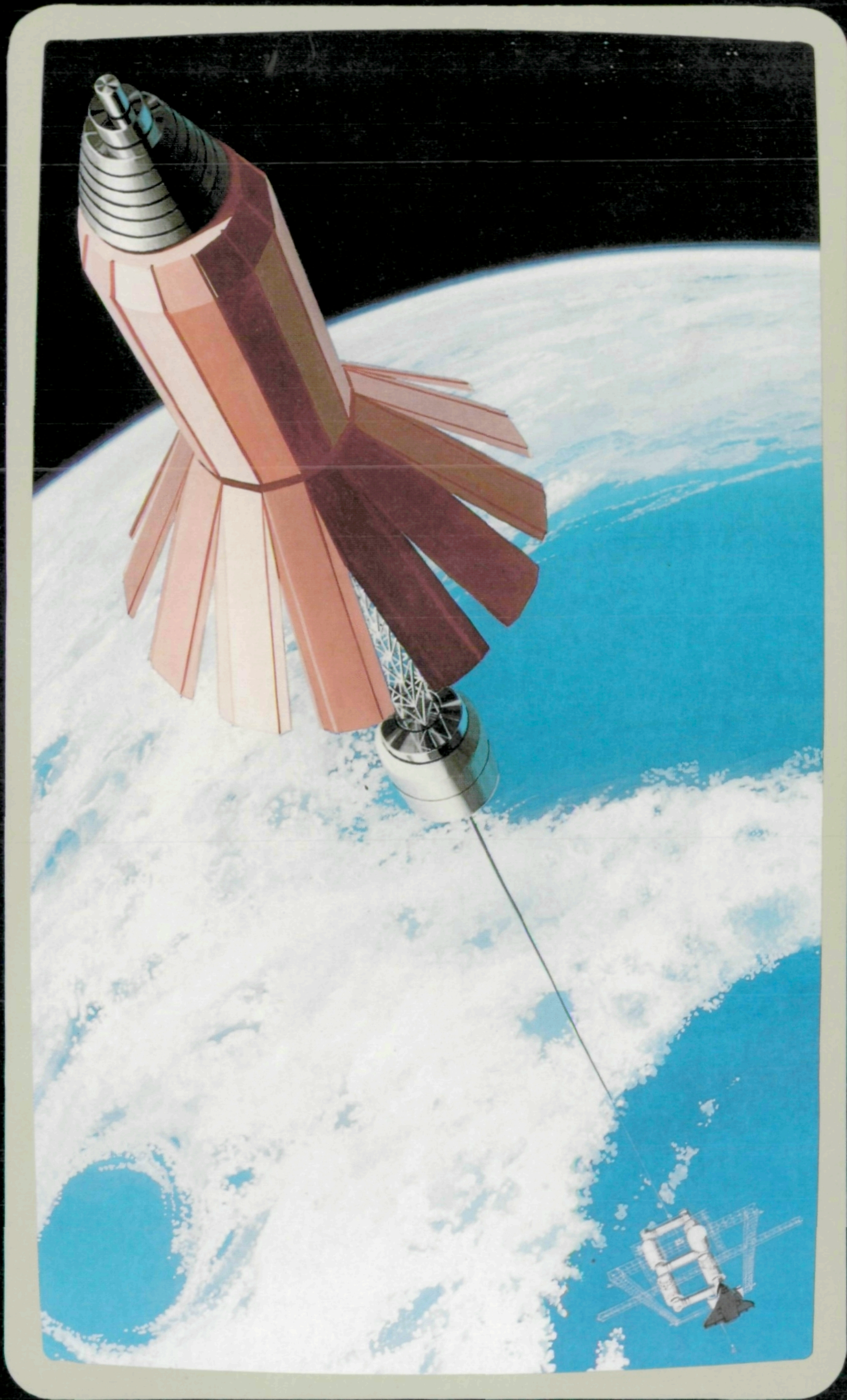
Lewis is working to increase the life and efficiency and decrease the cost and hardware mass of static space electric power systems. New solar cell materials and sunlight-concentrating devices that require smaller amounts of expensive solar cell material are being developed. New energy storage technologies include individual pressure vessel and advanced bipolar nickel-hydrogen batteries and regenerative fuel cells. Lewis is also pioneering the development of 20-kilohertz high-frequency, alternating-current power management and distribution systems.

Dynamic Systems

Lewis is developing advanced technologies for the SP-100 nuclear electric power system. Those technologies include heat-pipe radiators and radiation-tolerant collection devices. High-temperature solar dynamic systems will provide electric power for deep space exploration. Key technologies include high-temperature thermal energy storage; lightweight, accurate concentrators; and free-piston Stirling energy conversion.

Terrestrial Systems

Kinematic Stirling technology being developed by Lewis is expected to lead to an automobile engine that exceeds both the fuel economy and pollution standards mandated by the Federal Government.



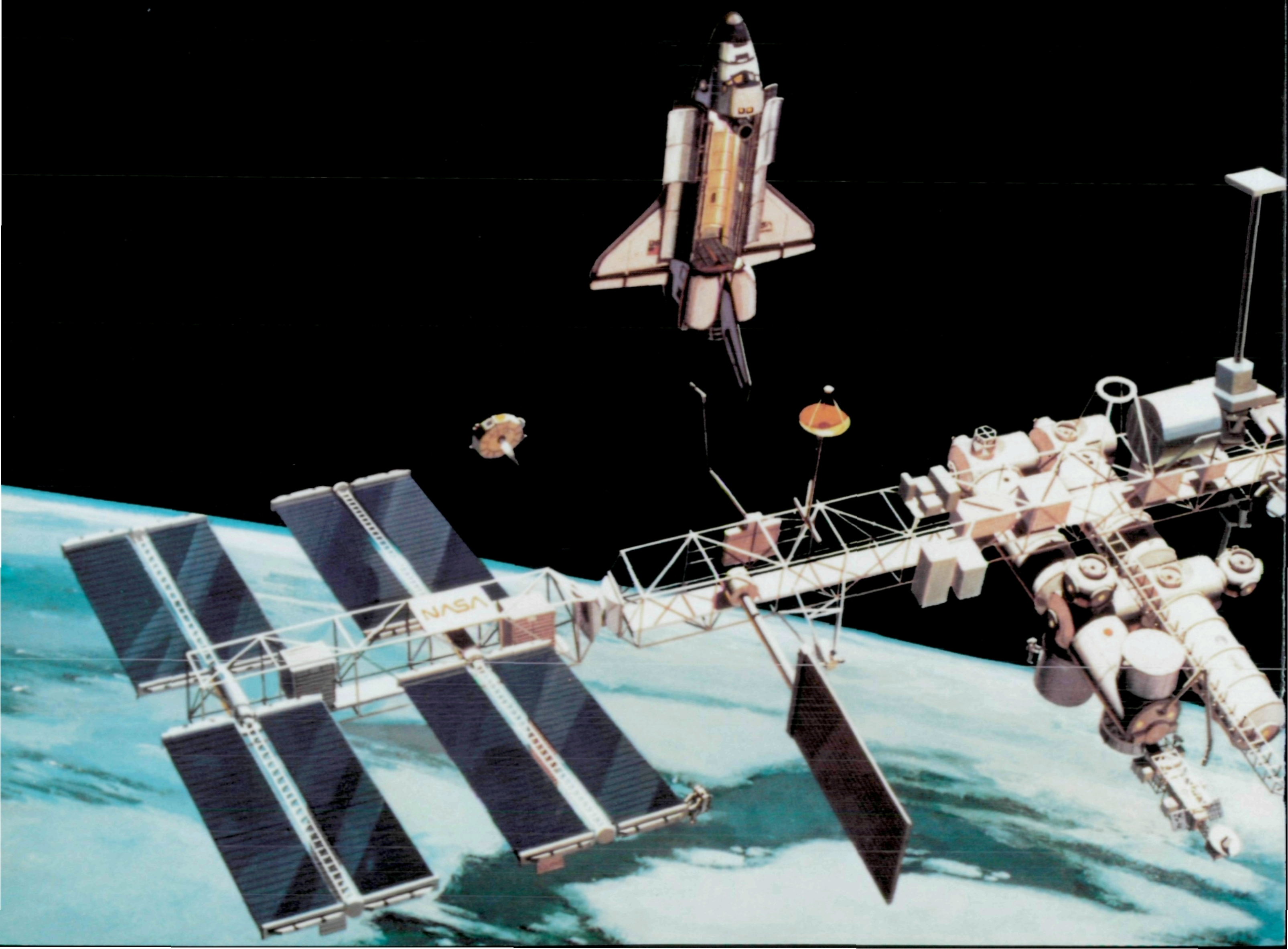
SPACE STATION: THE NEXT LOGICAL STEP

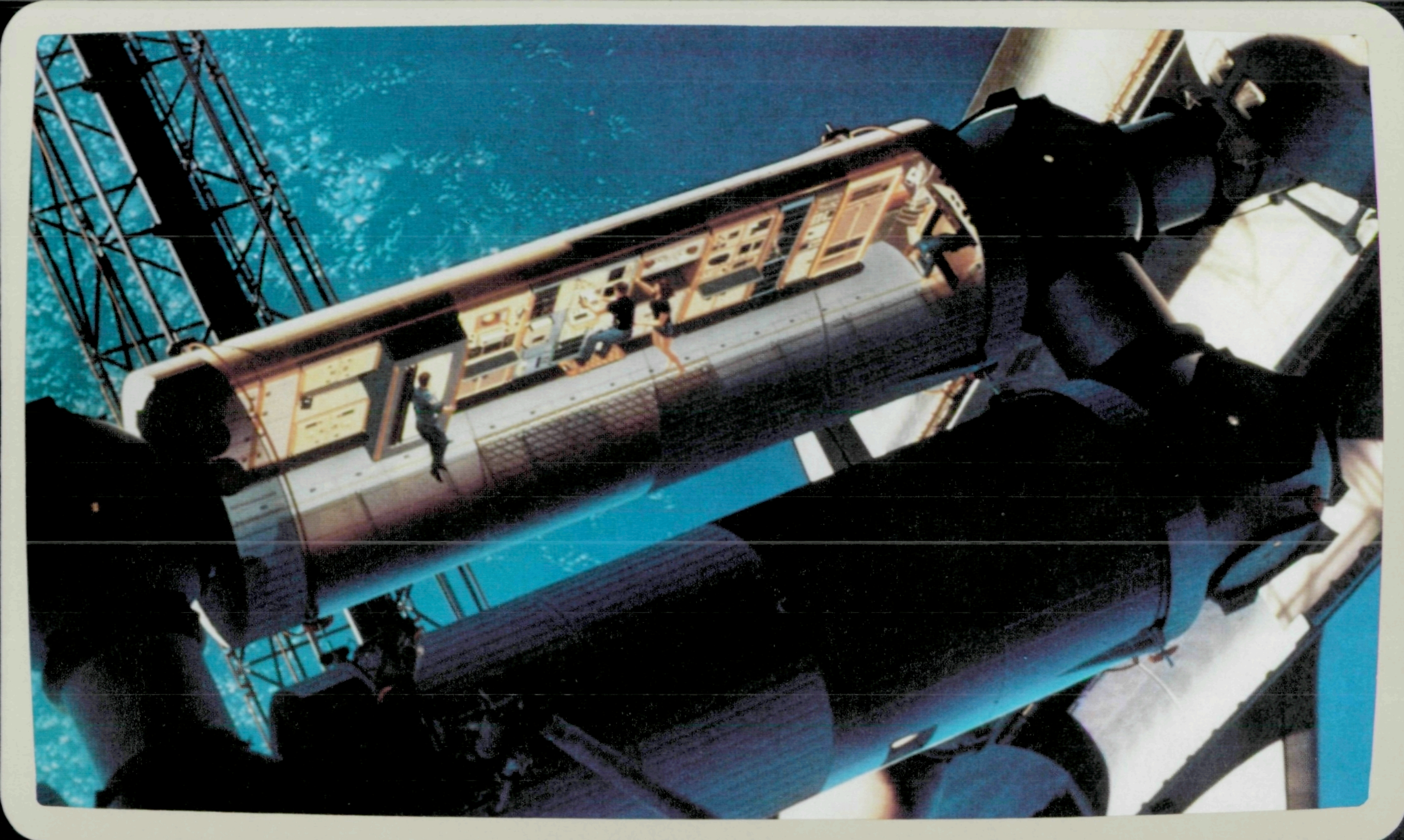
Pioneering the space frontier will require the establishment of a permanent human presence there. Space station, a multipurpose facility in low Earth orbit dedicated to scientific experiments and the development of new technologies, will provide that human presence.

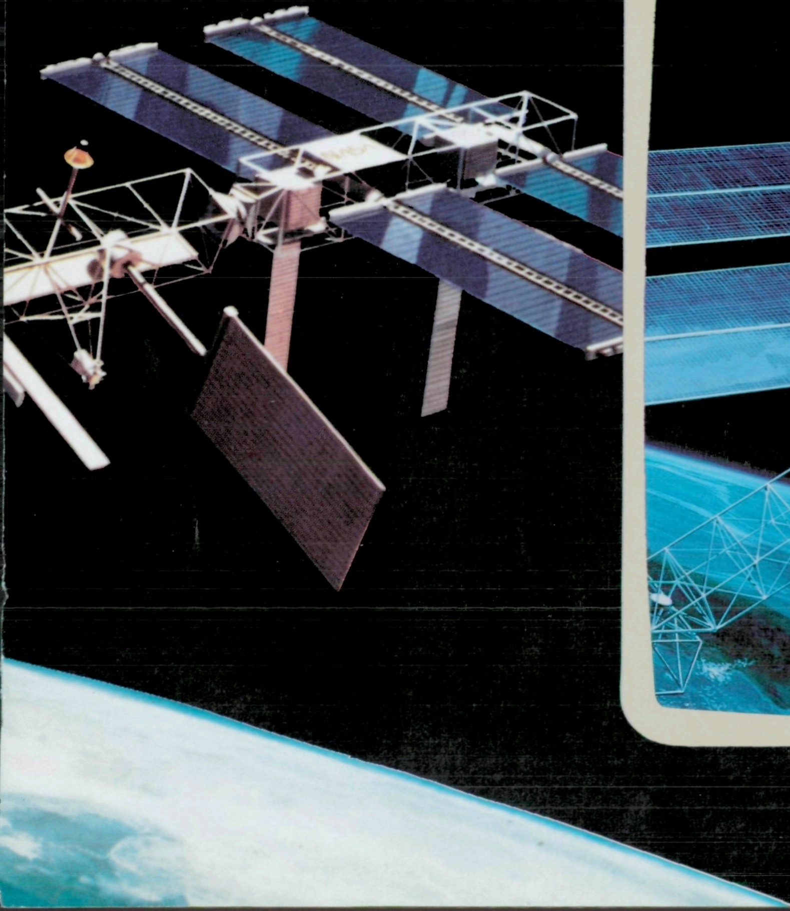
Lewis is responsible for the space station's power system, which will generate, store, condition, and distribute electric power. The power system will function as a miniature electric utility for a small community of people who will be living and working in space.

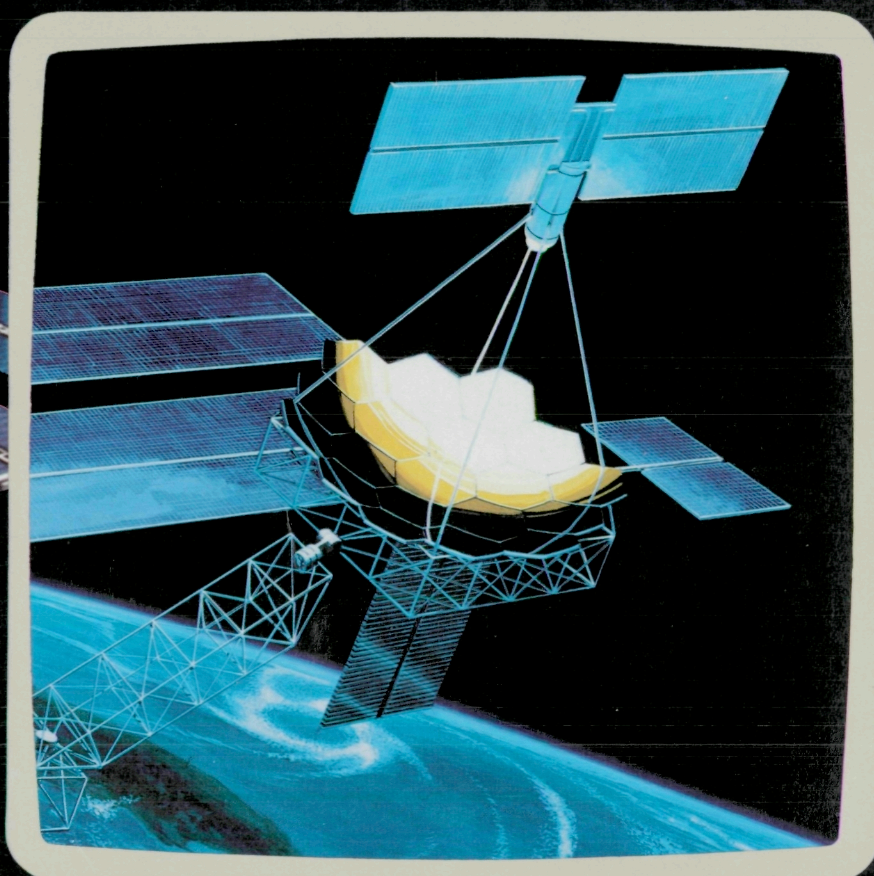
The initial power requirement, targeted at 75 kilowatts, will be for such essentials as life support systems, experiments, communications, and data handling. That power will be generated by a photovoltaic system.

Lewis also is responsible for the power management and distribution systems. Those systems will bring electric power to users throughout the space station at the correct voltages and frequencies.









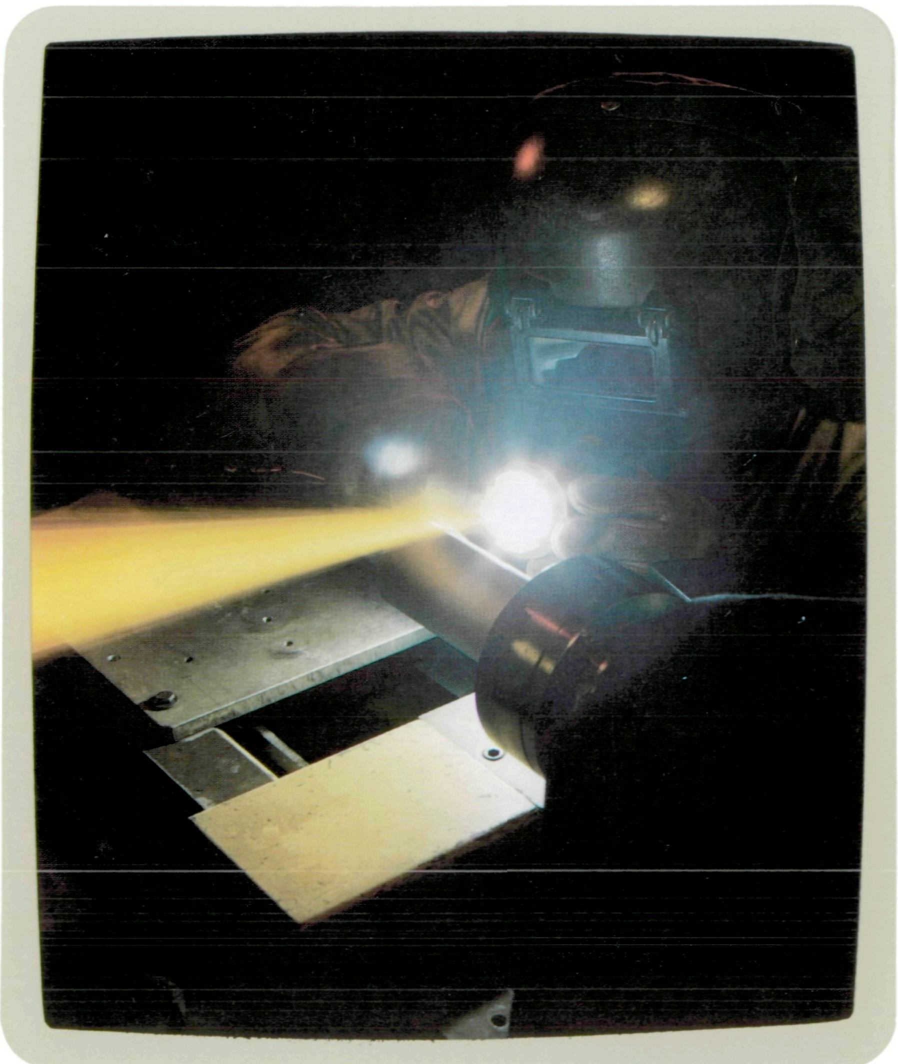
BASIC RESEARCH

Materials

Advances in materials and materials processing are vital to propulsion systems for space and aeronautics. Lewis has proved that metal-matrix composites can be 1.8 times stronger than the copper currently used in the combustion chamber of the space shuttle main engine. We also have shown that nickel aluminide, needed to withstand the high temperatures encountered in advanced airplane engines, can be made as strong as commercial nickel-base superalloys. Moreover, the nickel aluminide is lighter, contains no strategic materials, and offers better oxidation resistance.

Rapid solidification processing (1 million degrees Celsius per second) can radically affect the physical and metallurgical properties of materials. Copper alloys produced by this method have great potential for long life and offer high conductivity for use in rockets, shuttles, and orbit transfer vehicles.

Lewis has been designated the lead center for NASA's work in high-temperature superconductivity. We are involved in an aggressive program to develop high-temperature superconductor technology for aerospace applications. We are not only conducting in-house research, but also are collaborating with the Argonne National Laboratories in Chicago and with several universities.



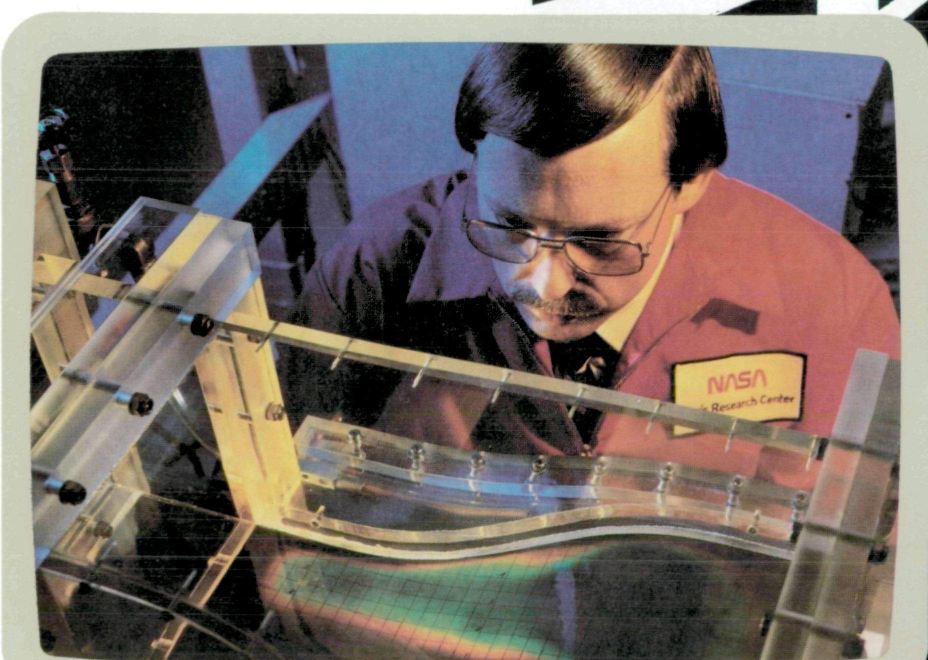
Structures

Turbine vanes, blades, and disks and rocket nozzle liners are subjected to complex in-service loads. Lewis is conducting laboratory studies of high-temperature phenomena in these structures and developing techniques to predict their durability. We are extending these techniques for application to multiaxial fatigue behavior, brittle materials (such as ceramics), composites, and environments of hydrogen gas and cryogenic fluids. We also are analyzing the dynamic response of structures to transient and vibratory loads and aeroelastic forces. New probabilistic analytical methods are being developed to take advantage of improvements in computers.

Microgravity Sciences

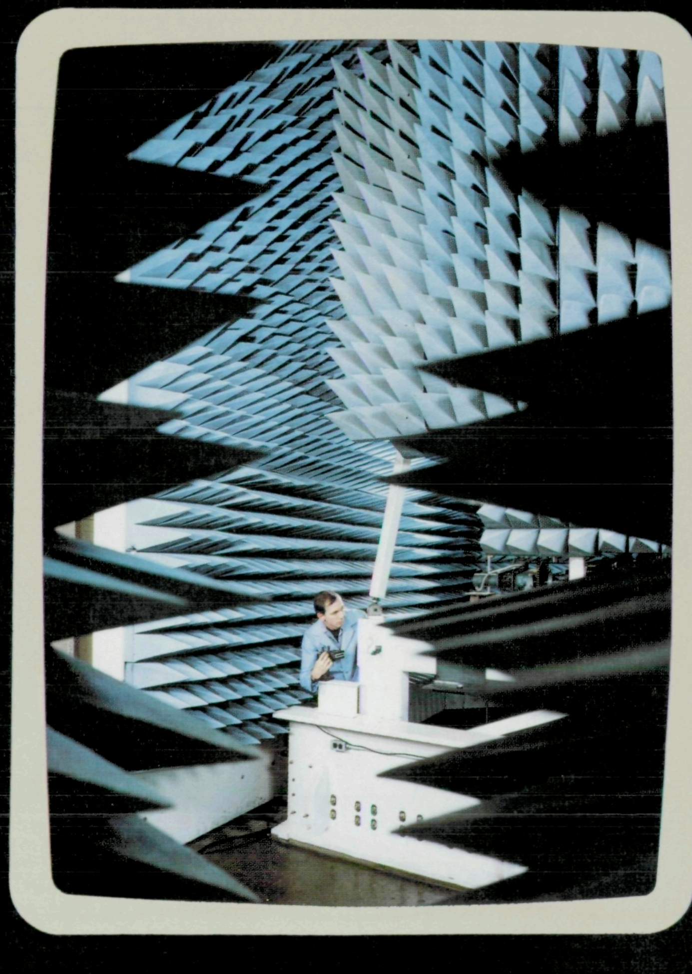
Understanding the role of gravity in the fundamentals of combustion science, materials science and processing, and fluid physics is the goal of the Lewis microgravity sciences program. The program supports basic and applied reduced-gravity research in electronic materials, metals, glasses and ceramics, combustion, and fluids and chemicals. Microgravity research permits scientists to eliminate gravity-driven forces and to concentrate on much more subtle interactions such as diffusion, solubility, and capillary action. This work is expected to lead to refined

theories and better control of physical processes. The benefits being sought are new materials, more efficient use of Earth's nonrenewable fuel resources, advanced computers and lasers, and better communications technology.

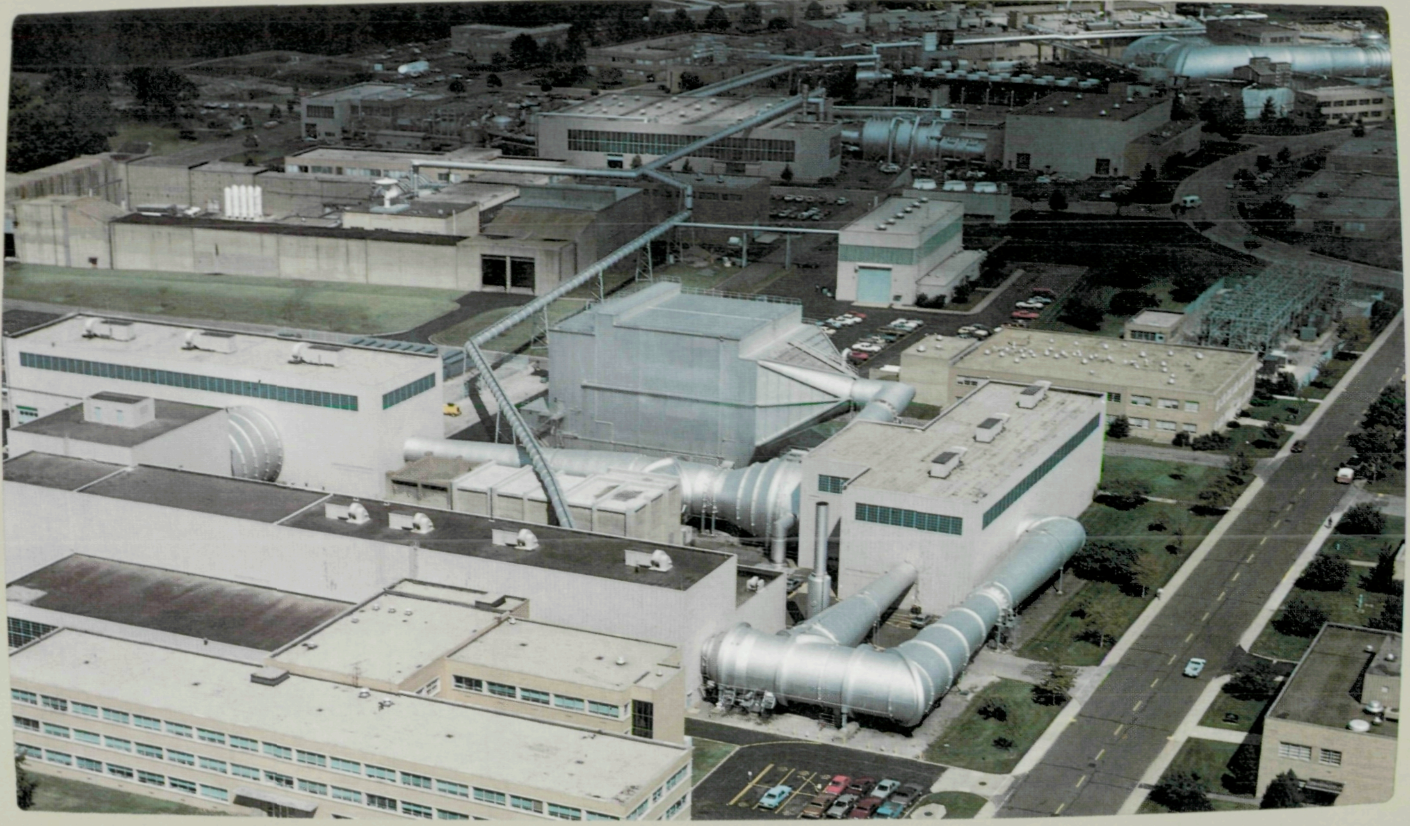


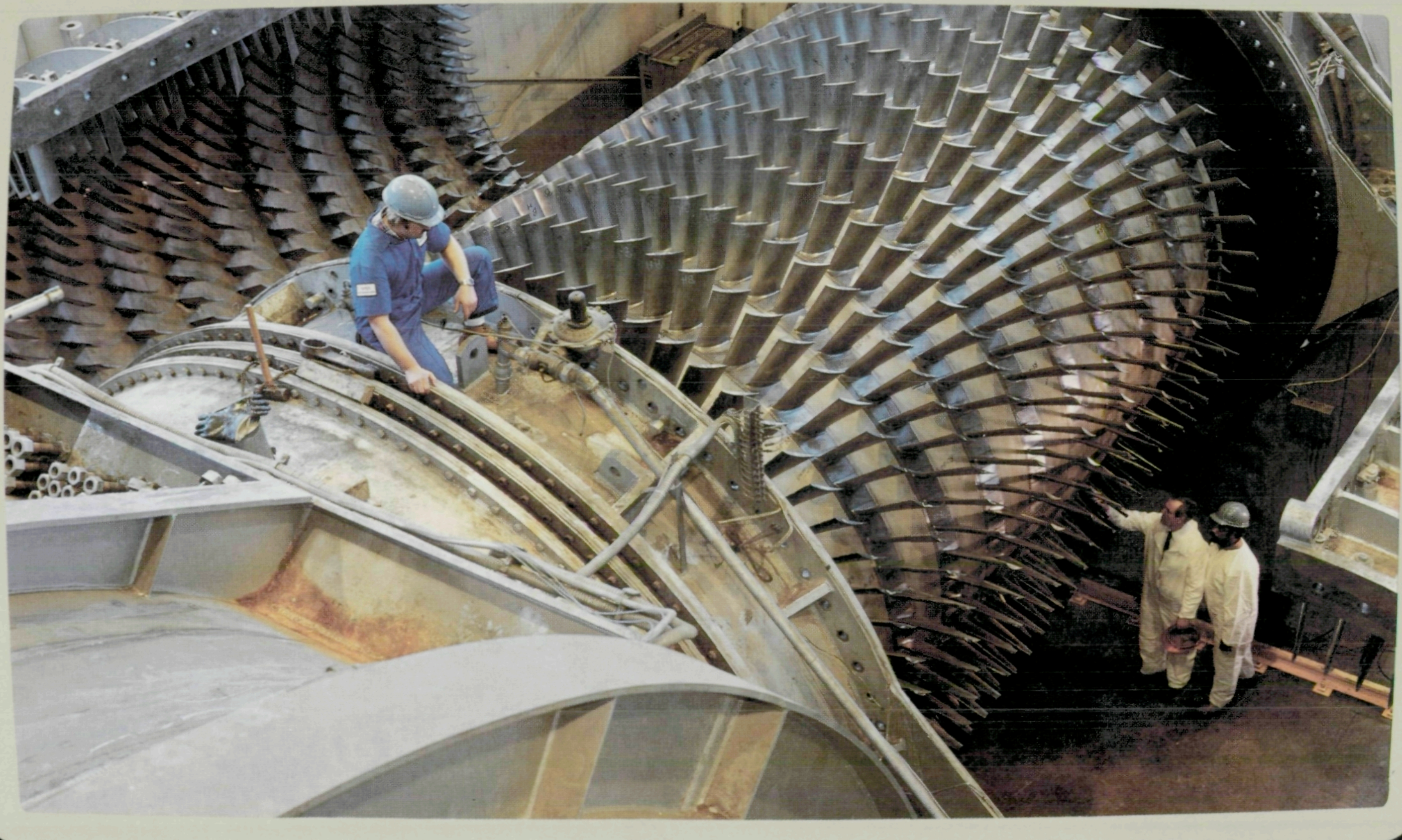
FACILITIES

Facilities at Lewis are among the finest in the world for developing and testing new materials, concepts, and processes. Engineering test cells are available for testing components in diverse simulated operating environments.



Large facilities that can test complete systems include two supersonic wind tunnels, large vacuum chambers for simulating a space environment, a 420-foot-deep zero gravity facility, altitude chambers for testing full-scale jet engines, a unique icing research tunnel, and the most modern rocket engine test facility in the nation. A new microgravity science laboratory, a drop tower, and a Learjet are available for visiting scientists and engineers to test potential shuttle and space station payload experiments.





SUPPORT

Lewis engineers enjoy the services of a dedicated support staff—from the design of research hardware to the processing of research reports.

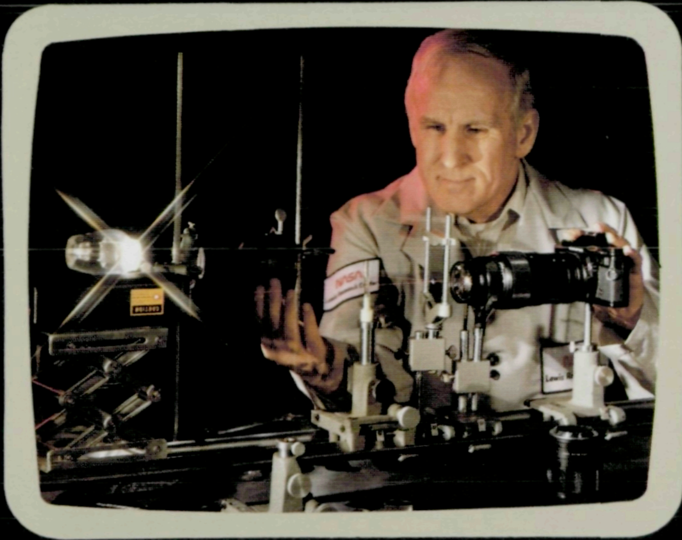
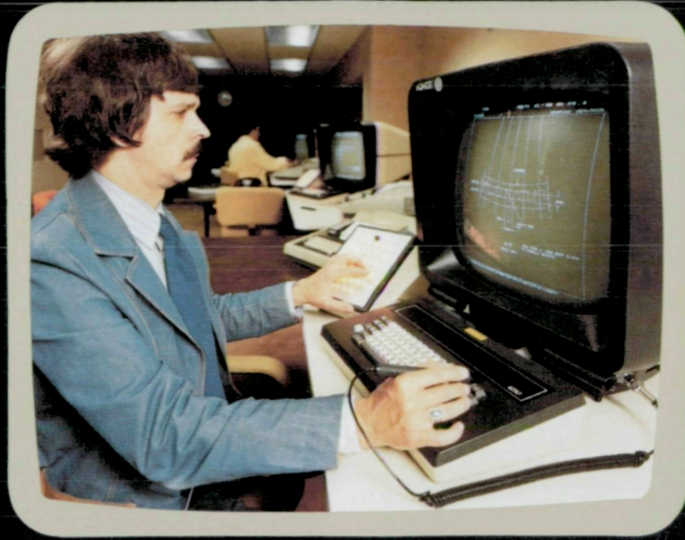
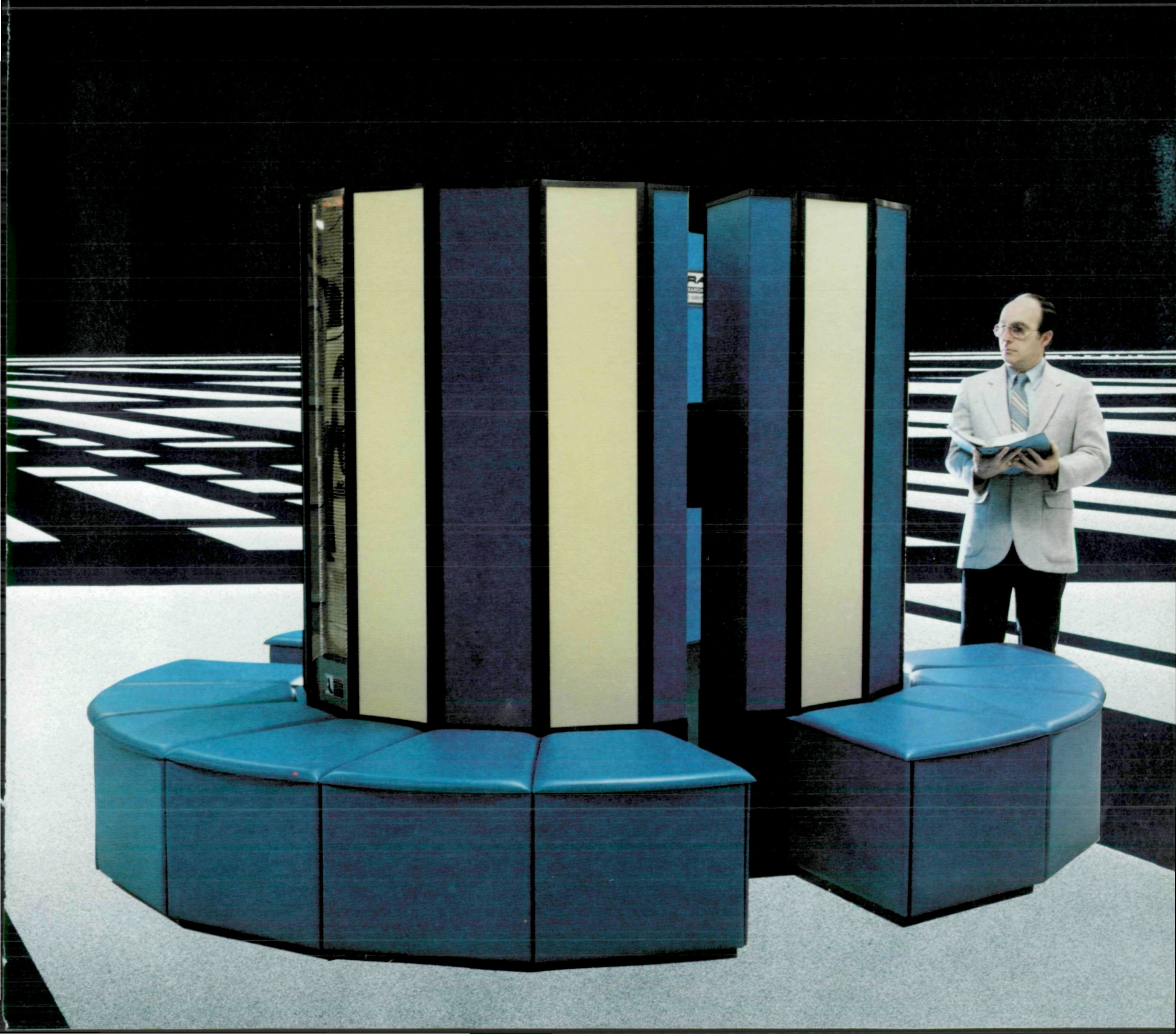
Prototypes and test models are built by a staff of skilled tradespersons using the most modern equipment available, including five-axis milling machines and one-of-a-kind setups that can drill holes smaller than a human hair. Extremely smooth surfaces (less than 1 microinch in roughness) can be produced, and dimensional repeatability to 40 millionths of an inch is possible. Hardware built at Lewis ranges in size from a 62-foot wind turbine blade to microminiature tools that are used for cataract operations.

The heart of the Lewis computing system, a Cray X-MP/24, supports the most advanced research at the Center. Amdahl and IBM mainframe computers serve as front-end access to the Cray and provide significant stand-alone research capability. Lewis also has sophisticated intracenter cable television and intercenter satellite communications.

Lewis is installing a network of individual personal computer workstations that gives every office employee access to the Lewis central computing capability. LIMS, for Lewis Information Management System, integrates office automation with personal computing services, offering such features as local databases, spreadsheets, and presentation graphics. A unique feature of LIMS is that it includes interactive graphic capability for engineering and scientific tasks.

Experienced editors, word processors and typesetters, photographers, and artists process research reports on the latest electronic equipment. Lewis has one of the best-equipped and best-staffed photographic laboratories in the Midwest, as well as a modern automated printing facility.

Lewis' automated technical library has extensive holdings and access to a vast Government- and industrywide computerized network.

A PARTNER WITH INDUSTRY

The primary mechanism in the United States for the application of new technology is industry. For that reason, Lewis works closely with the private sector to assist individual companies in the commercial use of space and to transfer technology developed for aerospace purposes to private companies for industrial application.

Through the Office of Space Commercialization, Lewis can offer technical expertise that will support private research initiatives in materials science, tribology, fluid physics, combustion, communications, space power, launch vehicles, and instrumentation.

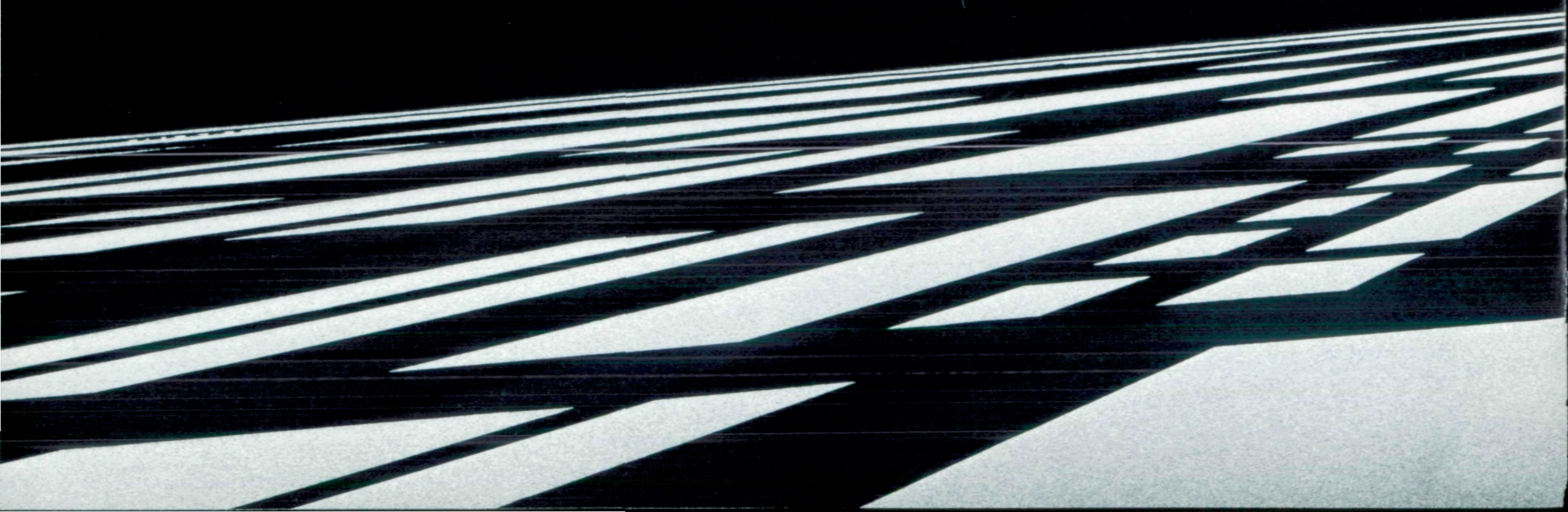
The Technology Utilization Office emphasizes the reuse of NASA technology to solve current industrial problems and to increase the efficiency of existing manufacturing operations. Information is disseminated through technology transfer conferences and workshops sponsored by Lewis; through the publication of Tech Briefs, which are summaries of promising scientific and engineering developments that could have application in the private sector; and by participating in industrial trade fairs.

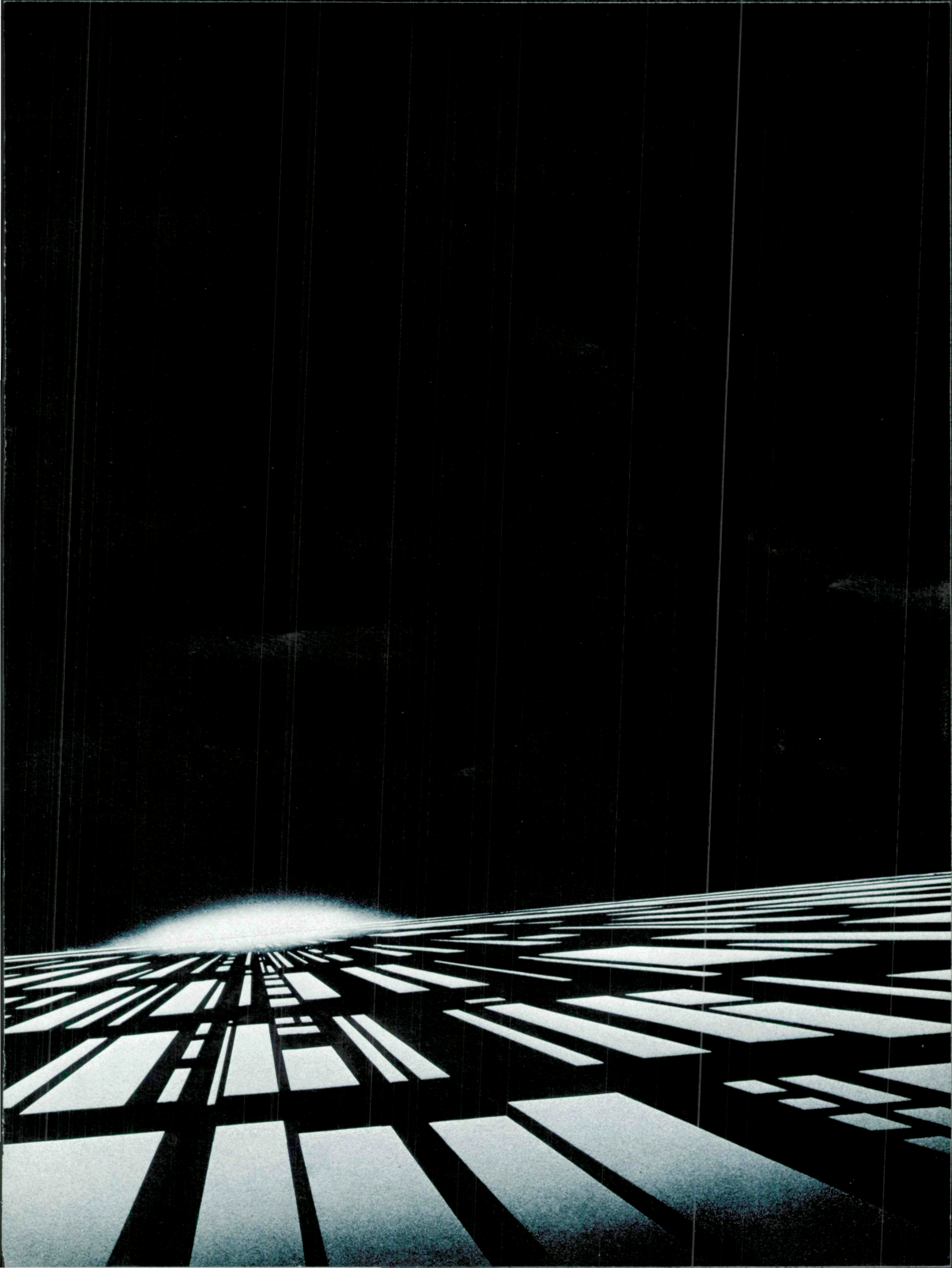
AN ENVIRONMENT FOR GROWTH

Lewis is an employer that provides outstanding opportunities for both personal and professional growth. Managers and supervisors encourage the presentation of technical papers to professional societies. Expert editorial, photographic, and graphic arts staffs offer in-depth support in preparing these presentations.

Those wishing to continue their education will find available everything from self-study courses in the Lewis Learning Center to programs leading to advanced degrees from nearby universities. New employees with bachelor's degrees in engineering and scientific disciplines are strongly encouraged to advance at least to the master's level in a career-related field, and on-site courses for credit are given to support the pursuit of such graduate degrees. Lewis may provide tuition support for part-time master's or doctoral studies at area universities. Selected employees may be awarded a leave of absence to pursue full-time doctoral studies with salary and tuition paid by the Center. Administrative personnel may also be assisted with graduate study. Such support is based on the job relatedness of the study, work performance, and past academic achievement.

The atmosphere at Lewis is genuinely unique. Daily contact with people and projects in private industry and in the university community allows for the kind of interaction and exchange of ideas that leads to truly meaningful contributions and the satisfaction of knowing that those contributions are part of major technological progress. The atmosphere for contribution is further enhanced by the active seeking out of new ideas for progress and improvement through quality circles and a strong participative management program.





AN ALL-AMERICA CITY

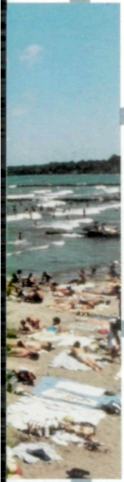
Cleveland has been designated an All-America City by the National Civic League. Criteria for that award are based on citizen participation in developing solutions to modern urban problems.

Cleveland offers a quality and depth of culture and entertainment that few cities can match. The Cleveland Playhouse is the home of the oldest repertory company in the country, and the annual Shakespeare festival is one of the highlights of the summer months. The Cleveland Orchestra, applauded throughout the world, performs at beautiful Severance Hall during the winter months and plays outdoors at Blossom Music Center in the summer. Touring Broadway casts perform at the Hanna, Ohio, and State theaters, and jazz and pop music fans can enjoy their favorite performers on tour.

The Cleveland Museum of Art houses one of the world's finest collections. Other outstanding museums in the area include the Museum of Natural History, the Crawford Auto-Aviation Museum, and the Western Reserve Historical Society.

The Cleveland Zoo and three major amusement parks less than an hour's drive from Cleveland provide lighter enjoyment for the family. Professional football, baseball, indoor soccer, and basketball are available to entertain the spectator throughout the year. The participating enthusiast will find boating, snow and water skiing, polo, and golf within easy reach.

The rich and diverse ethnic heritage of the Cleveland area means dining excellence and variety—from world-class ribs to the finest haute cuisine—that will please the most adventurous palate.

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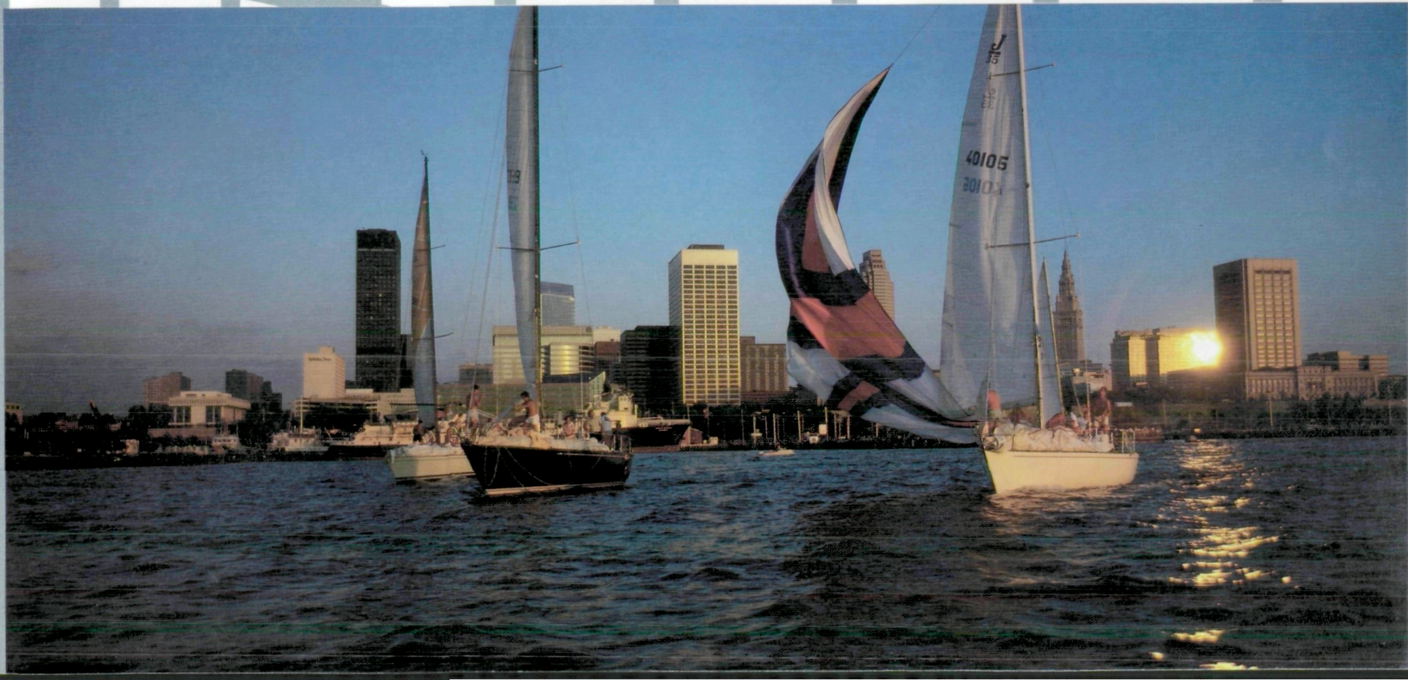
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The Lewis Charter

Meet national needs and NASA objectives through research, technology, and system development for aeronautics, space exploration, and space utilization

- **Technological Leadership**

  Performing basic and applied research and technology development in aeropropulsion, space propulsion, space power, microgravity science, and communications and in key related disciplines

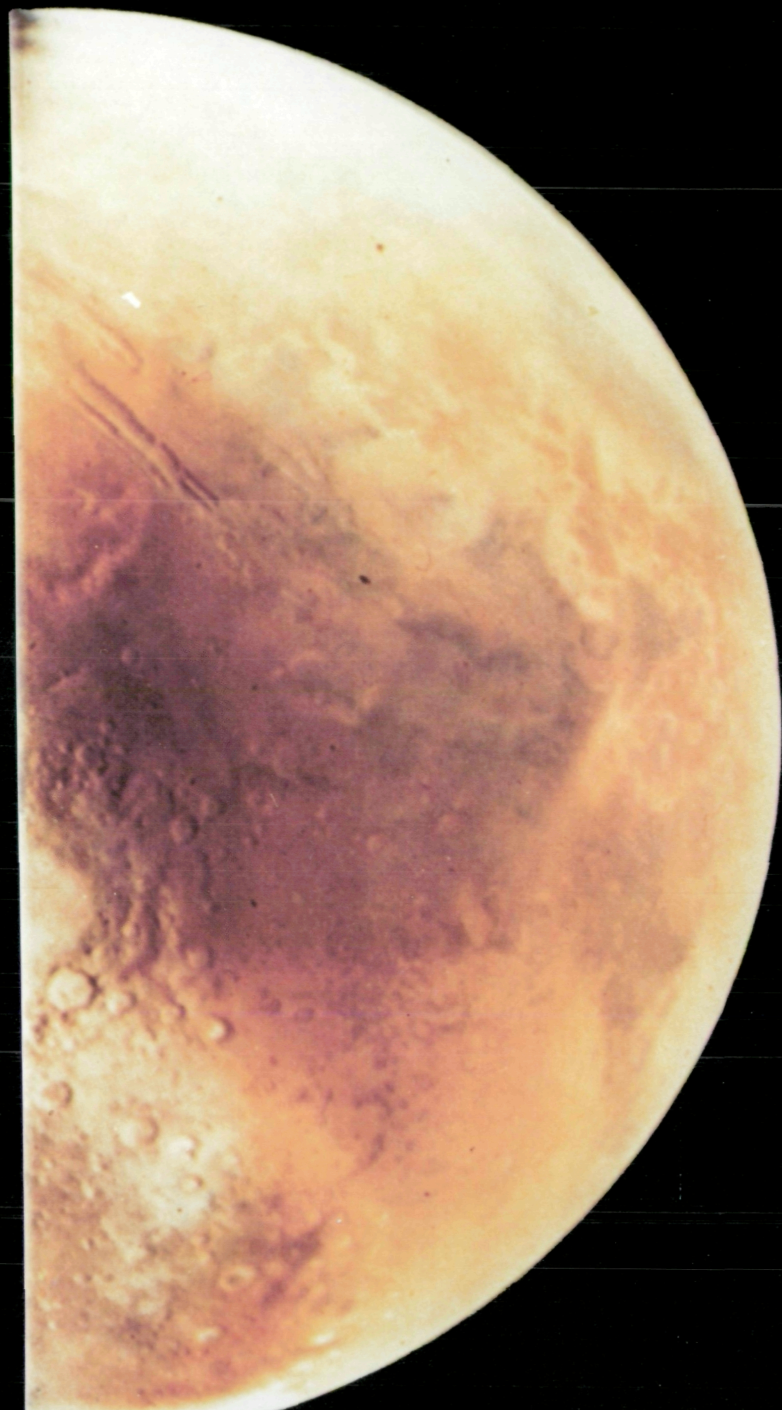
  Managing selected technology validation and flight system development projects that flow from and/or drive our research and advanced technology

- **Institutional Health**

  Developing and maintaining excellence in our staff, facilities, and information systems

- **External Image**

  Demonstrating technical and managerial leadership, thus ensuring widespread recognition and use of our capabilities and technology



The most beautiful thing we can experience is the mysterious. It is the source of all true art and science.

—*Albert Einstein*

National Aeronautics and
Space Administration

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